

European cancer mortality predictions for the year 2013

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Background: Estimated cancer mortality statistics were published for the years 2011 and 2012 for the European Union (EU) and its six more populous countries.

Patients and methods: Using logarithmic Poisson count data joinpoint models and the World Health Organization mortality and population database, we estimated numbers of deaths and age-standardized (world) mortality rates (ASRs) in 2013 from all cancers and selected cancers.

Results: The 2013 predicted number of cancer deaths in the EU is 1 314 296 (737 747 men and 576 489 women). Between 2009 and 2013, all cancer ASRs are predicted to fall by 6% to 140.1/100 000 in men, and by 4% to 85.3/100 000 in women. The ASRs per 100 000 are 6.6 men and 2.9 women for stomach, 16.7 men and 9.5 women for intestines, 8.0 men and 5.5 women for pancreas, 37.1 men and 13.9 women for lung, 10.5 men for prostate, 14.6 women for breast, and 4.7 for uterine cancer, and 4.2 and 2.6 for leukaemia. Recent trends are favourable except for pancreatic cancer and lung cancer in women.

Conclusions: Favourable trends will continue in 2013. Pancreatic cancer has become the fourth cause of cancer death in both sexes, while in a few years lung cancer will likely become the first cause of cancer mortality in women as well, overtaking breast cancer.

Key words: breast cancer, cancer, Europe, mortality, projections, time trends

Introduction

Estimates of current cancer mortality statistics, extrapolated from official data of a few years earlier, have long been available for the USA [1–3] and have been published for the years 2011 and 2012 for the European Union (EU) as a total and for its six more populous countries [4, 5], based on the World Health Organization (WHO) mortality database [6].

Here, we provide corresponding figures for the year 2013 using the same methodology and the WHO study database updated to July 2012. This report also focuses specifically on colorectal cancer, presenting the number of deaths and rate estimates separately for various age groups, and discussing reasons for age- and sex-specific trends.

Materials and methods

This work is an update to the previous articles on predicted European cancer mortality and is based on similar methods [4, 5].

Official death certification data from stomach, intestines (colon and rectum), pancreas, lung, breast, uterus (cervix and corpus), prostate, leukemias and total cancer mortality were obtained from the WHO database (WHOSIS) [6]. Figures were derived for the EU in the period 1970–2009 and up to the most recent available year for six European countries: France (2010), Germany (2010), Italy (2009), Poland (2010), Spain (2010) and the UK (2010). The EU was defined as the current 27 member states. Data for Cyprus were not available. For the calculation of the EU rates, when data were not available for a country, the nearest available data were replicated (see supplementary Appendix 1, available at *Annals of Oncology* online). No interpolation was made for missing data in individual countries.

During the calendar period considered, three different Revisions of the International Classification of Diseases (ICD) were used. Cancer deaths were re-coded according to the Tenth Revision of the ICD [7]. ICD-10 encoding of the studied cancers was: stomach cancer (C16), intestinal (mainly colon and rectum) cancer (C17–C21, C26), pancreas (C25), lung (C33–C34), breast (C50), uterus (cervix and corpus) (C53–C55), prostate (C61), leukemias (C91–C95) and total cancers (C00–D48).

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Estimates of the resident population were obtained from the same WHO database. France and the UK lacked population data for 2009 and 2010, respectively, which were obtained from Eurostat instead [8]. Population projection estimates for the year 2013 were obtained from Eurostat.

We computed age-specific rates and numbers of deaths for each 5-year age group (from 0–4 to 80+ years) and calendar year. Age-standardized rates (ASRs), per 100 000 men and women, were computed by the direct method, using the world standard population [9]. Quinquennial all-ages standardized (world population) mortality rates were also calculated, as well as quinquennial and annual standardized mortality rates for colorectal cancer for the all-ages, 35–64 and 65–79 age groups.

A logarithmic Poisson count data joinpoint model was fitted to 5-year age-specific numbers of deaths in order to identify the most recent trend segment. The joinpoint model was set to a maximum of six identifiable segments (five joinpoints) and to have at least five data-points from the last available period [10]. A linear regression was then carried out over the identified trend segment in order to compute predicted age-specific numbers of deaths, the corresponding 95% confidence intervals (CIs) and prediction intervals (PIs) [11]. Predicted age-specific and ASRs (with 95% CI and PI) were computed using the predicted population data.

results

Table 1 shows total numbers of predicted deaths and standardized death rates for the analyzed neoplasms with 95% PI and CI, in the EU as a whole in 2013 as well as comparison data for 2009. Total predicted number of cancer deaths in the EU in 2013 is 1 314 236 compared with 1 281 694 in 2009. Of these, 737 747 are men and 576 489 women, against 718 478 men and 563 216 women recorded in 2009. These figures correspond to total cancer death rates of 140.1/100 000 men and 85.3/100 000 women in 2013 in the EU, marking a 6% fall in men and a 4% fall in women since 2009. In men, lung cancer was responsible for most cancer deaths (25%) with nearly 187 000 predicted deaths giving a rate of 37.2/100 000 men in 2013, corresponding to a 6% fall since 2009. In women, breast cancer accounted for the largest number of predicted cancer deaths (88 886 deaths, 14.6/100 000 women, 15% of total) in 2013, corresponding to a 7% fall in rates since 2009 in the EU. Female lung cancer deaths come a very close second with 82 640 deaths (14% of total) in 2013 with a rate of 13.9/100 000 women, marking a 7% rise since 2009. Pancreatic cancer also had unfavourable mortality rates (8/100 000 men and 5.5/100 000 women) for 2013; these are higher than those of 2009 (7.9/100 000 men and 5.3/100 000 women) even though by a very small margin. Figure 1 includes bar-plots of standardized death rates and deaths for 2009 and the predicted rates and deaths for 2013 with 95% PIs for total cancer mortality in the EU in men and women. Figure 2 shows mortality rates in 2009 and 2013 in the EU men and women for the individual cancer sites.

Figures 3 and 4 illustrate trends in age-standardized cancer mortality rates for EU men and women in 5-year steps from 1970 to 2009 and the predicted rates for 2013 for all cancers (Figure 3) and individual sites (Figure 4). Recent trends for the

examined cancer sites in the EU are favourable in both sexes with few exceptions, confirming the favourable trend in total cancer mortality since the late 1980s' in men and earlier in women. The main drivers of these favourable trends in men are lung cancer, which has been decreasing since mortality peaked in the late 1980s and stomach cancer, which has been decreasing for several decades. In women, the falling rates are mainly influenced by decreases in breast, intestinal and stomach cancer. Breast cancer mortality peaked in the 1990s and has been falling since, while intestinal and stomach cancer mortalities have been falling for the entire period. Pancreatic cancer is the only cancer site with unfavourable trends in both sexes and the only one in men. In women, lung cancer mortality confirms its rising trend.

Supplementary Figure S1, available at *Annals of Oncology* online, illustrates age-standardized (world population) cancer mortality rate trends for men and women in quinquennia from 1970–1974 to 2005–2009 and the predicted rates for 2013 for cancers of the stomach, intestines, pancreas, lung, breast, uterus, prostate and leukemias in the studied countries and the EU.

Overall cancer mortality trends were favourable all round for both sexes and reflected the differences between countries in individual cancer sites. Male total cancer predicted rates reflected those of lung cancer, Poland having the highest rate (175.3/100 000 men), substantially higher than the EU value. Female overall predicted rates were highest in Poland and the UK (between 95 and 100/100 000 women), while the lowest was in Spain (67.8/100 000 women).

A detailed description of trends for selected cancer sites is given in supplementary Appendix 2, available at *Annals of Oncology* online.

Further details on country-specific data can be found in supplementary Tables S1–S6, available at *Annals of Oncology* online, which give total numbers of predicted deaths and standardized death rates for the analyzed neoplasms with 95% PI and CI for men and women, in the six examined European countries in 2013 as well as comparison data from the last available year in each country.

Table 2 gives age-standardized intestinal cancer mortality rates in the EU and the six most populous member countries, for all-ages, the 35–64 and 65–79 year age groups in the quinquennia 2000–2004 and 2005–2009, with percentage differences, as well as the 2013 predicted rates. Poland and Spain show an unfavourable situation compared with other EU countries and the whole EU, with predicted rates (21.8/100 000 men, Poland all-ages and 18.6/100 000 men, Spain all-ages) that are both higher than those in 2005–2009 in men and higher than those of other European countries and the EU (16.7/100 000 men). In women, Polish rates are still the highest, but the projected rates for 2013 are lower than those of 2005–2009 in the all-ages (10.8/100 000 women) and 65–79 age groups (93.1/100 000 women). Conversely, Polish middle-aged women have a slightly higher 2013 rate compared with 2005–2009. Despite Spanish women having low total predicted colorectal cancer rates (9/100 000 women) compared with the EU (9.5/100 000 women), the middle-aged women's predicted rate (11/100 000 women) is higher than that recorded for 2005–2009 (10.9/100 000 women), a pattern similar to that of

Table 1. Number of predicted deaths and standardized mortality rates in the EU for the year 2013, with 95% prediction and confidence intervals, with comparison data from 2009.

Sex	Cancer	Number of deaths 2009	Predicted number of deaths 2013	Lower prediction limit (95%)	Upper prediction limit (95%)	Lower confidence limit (95%)	Upper confidence limit (95%)	World standardized death rate 2009	Predicted world standardized death rate 2013	Lower prediction limit (95%)	Upper prediction limit (95%)	Lower confidence limit (95%)	Upper confidence limit (95%)
Men	Stomach	36 574	34 767	34 190	35 344	34 383	35 151	7.46	6.59	6.48	6.70	6.52	6.66
	Intestine (colon and rectum)	87 818	91 751	90 566	92 937	90 860	92 643	17.30	16.71	16.46	16.97	16.51	16.92
	Pancreas	36 713	40 069	39 493	40 645	39 642	40 496	7.85	8.01	7.89	8.13	7.91	8.11
	Lung	18 3782	18 6970	18 4434	18 9506	18 5035	18 8904	39.57	37.18	36.66	37.70	36.76	37.60
	Prostate	69 069	70 347	69 230	71 465	69 596	71 099	11.38	10.52	10.36	10.67	10.42	10.62
	Leukaemias	22 025	22 653	22 080	23 226	22 234	23 072	4.64	4.19	4.02	4.36	4.10	4.28
	All cancers (malignant and benign)	718 478	737 747	730 074	745 419	731 736	743 757	148.37	140.06	138.48	141.65	138.79	141.34
Women	Stomach	24 040	21 446	20 788	22 105	21 009	21 884	3.43	2.91	2.80	3.02	2.83	2.98
	Intestine (colon and rectum)	75 059	75 360	74 441	76 279	74 748	75 972	10.11	9.54	9.40	9.69	9.44	9.64
	Pancreas	36 664	40 197	39 521	40 873	39 727	40 667	5.33	5.54	5.46	5.63	5.48	5.61
	Lung	73 616	82 640	81 495	83 785	81 833	83 447	13.03	13.94	13.71	14.17	13.78	14.11
	Breast	89 465	88 886	87 700	90 072	88 033	89 739	15.80	14.64	14.40	14.87	14.46	14.81
	Uterus (cervix and corpus)	27 596	27 446	26 913	27 979	27 017	27 876	5.00	4.69	4.57	4.81	4.60	4.79
	Leukaemias	17 951	18 288	17 906	18 669	18 013	18 562	2.81	2.56	2.46	2.66	2.50	2.61
	All cancers (malignant and benign)	563 216	576 489	571 864	581 115	572 932	580 047	88.95	85.34	84.56	86.12	84.73	85.96

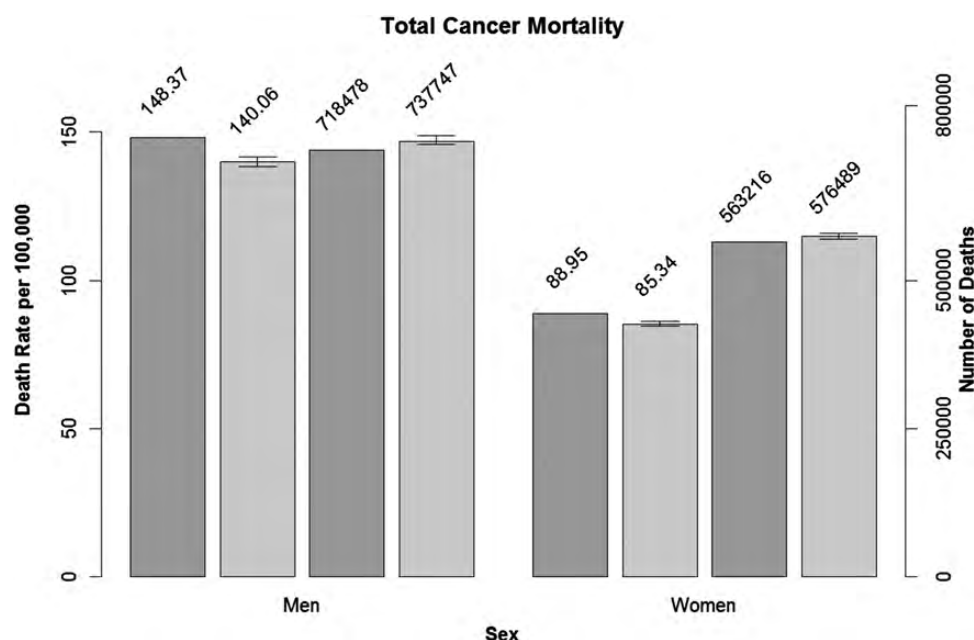


Figure 1. Bar-plots of standardized death rates per 100 000 population and certified deaths for the year 2009 (dark grey) and the predicted rates and number of deaths for 2013 with 95% PIs (light grey) for total cancer mortality in the EU in men and women.

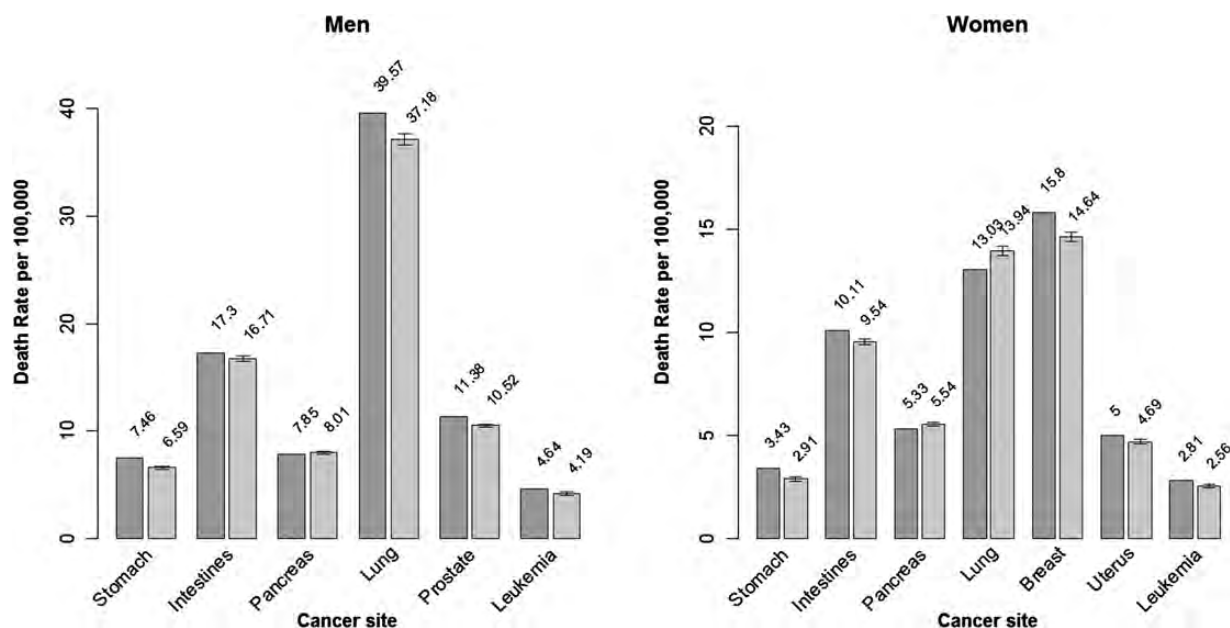


Figure 2. Bar-plots of standardized death rates per 100 000 population for the year 2009 (dark grey) and the predicted rates for 2013 with 95% PIs (light grey) for the EU in men and women in the studied cancer sites.

Polish women, albeit with lower rates. All other countries showed 2013 predicted rates smaller than those from 2005 to 2009. Figure 5 shows annual colorectal age-standardized death rates in the EU per 100 000 population for all-ages, 35–64 and 65–79-year age groups from 1970 to 2009 and the resulting joinpoint regression models for men and women, in addition to the predicted rates for 2013 with 95% PIs. EU colorectal cancer mortality trends should remain favourable even though the truncated 35–64 age group trend appears less favourable than for the other age groups.

discussion

The predicted number of deaths from cancer in the EU in the year 2013 is 1 314 296 (737 747 men and 576 489 women), slightly higher than the one in 2009. This slight increase in deaths is due to population ageing. Between 2009 and 2013, the age-adjusted mortality rates from all cancers are predicted to fall by 6% in men and 4% in women, thus continuing the favourable trends observed since the late 1980s in men and since earlier in women [12]. Male all-cancer mortality rates are

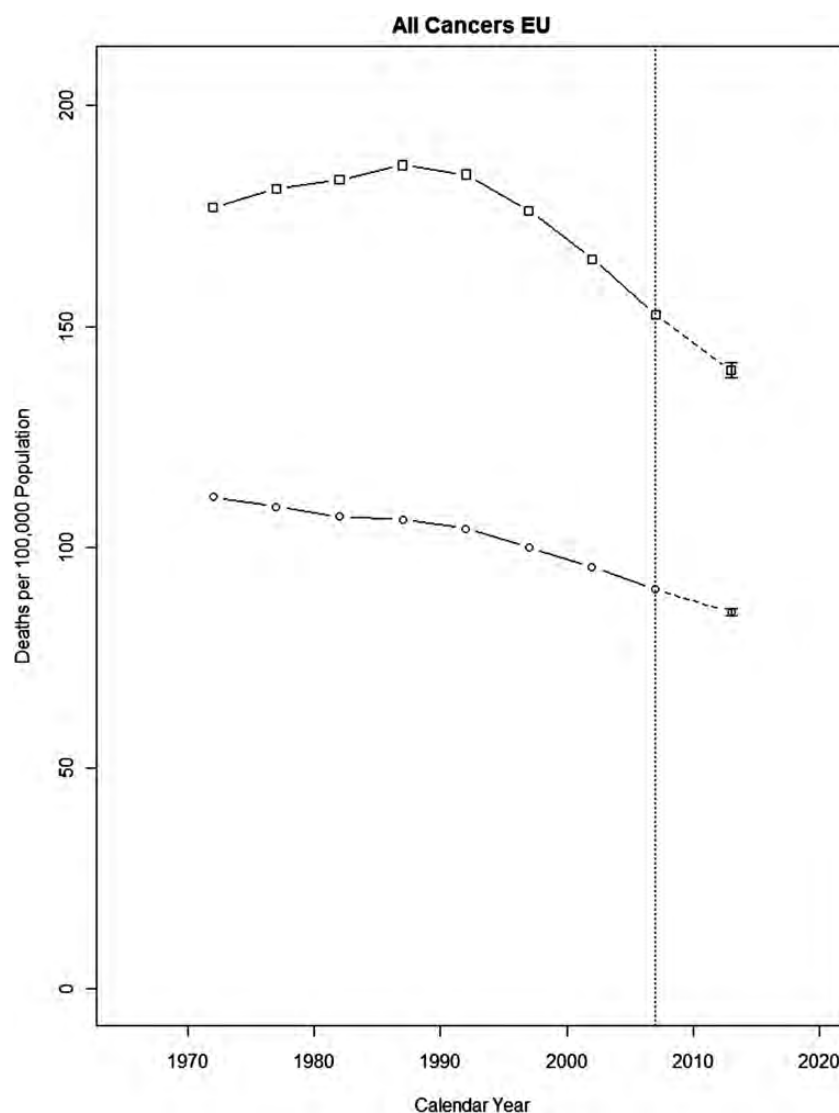


Figure 3. Age-standardized (world population) total cancer mortality trends in quinquennia from 1970–1974 to 2005–2009 and the predicted rates for 2013, for men (squares) and women (circles) in the EU.

about 65% higher than in women, and the recent greater fall in men only marginally reduces the gap. The slower decrease in female all-cancer mortality rates is largely due to the differential trends between the two sexes in lung cancer mortality, which is decreasing in men and increasing in women. This mirrors the differential trends in smoking prevalence observed in the past between the two sexes [13, 14].

The EU rates represent a weighted average of the rates in the 27 individual countries. The six countries considered, being the most populous, have a great impact on the overall rate; however, other EU countries may have an influence on the EU rate. Among the six major countries, the lowest all-cancer mortality rate in men in 2013 is in the UK, 10% lower than the EU rate. The lowest rate in women is found in Spain, 20% lower than that in the EU. Poland shows the highest rates in both sexes, 25% higher than that in the EU in men and 13% higher in women. Within the EU, there are large disparities in cancer mortality, showing that there is still large room for

improvement. On a positive note, all-cancer mortality rates are predicted to continue to decline in both sexes everywhere, although the gap between Poland and the other countries does not appear to decline.

The steady decline in stomach cancer mortality that started several decades ago, in Europe as well as other areas of the world, is still continuing [15]. This may reflect declines in the prevalence of *Helicobacter pylori* infection, the main identified risk factor for gastric cancer, but dietary habits, as well as the fall of smoking in men, may also have played a role [16]. Still, among the cancer sites considered, stomach is the one that shows the largest variation between countries, with an over threefold difference between the highest rates in Poland and the lowest in the UK, suggesting that a large number of stomach cancer deaths is still avoidable. An age-period-cohort analysis of gastric cancer mortality rates in Europe [17] found that an asymptote may have been reached for cohorts born after 1940 in British and French men and in some Western

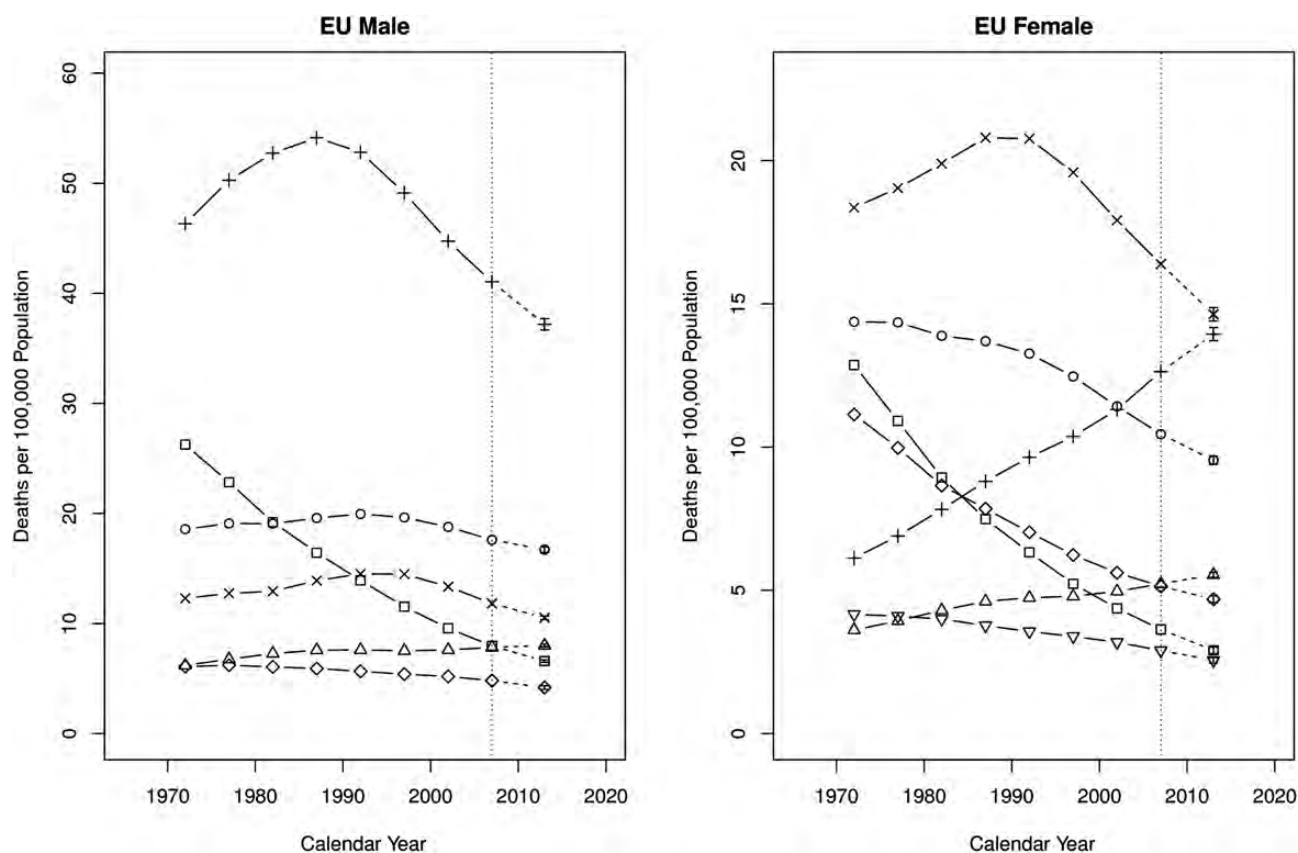


Figure 4. Age-standardized (world population) EU male and female cancer mortalities in quinquennia from 1970–1974 to 2005–2009 and the predicted rates for 2013. Men: stomach (squares), intestines (circles), pancreas (triangles), lung (crosses), prostate (xs) and leukemias (diamonds). Women: stomach (squares), intestines (circles), pancreas (triangles), lung (crosses), breast (xs), uterus (diamonds) and leukemias (inverted triangles).

countries with very low rates in women. Conversely, cohort effects continued to decline in countries with higher rates, suggesting that in the future, rates will converge towards low values.

Steady declines are also predicted in both sexes for leukaemia, in women for breast and uterine cancers and in men for prostate cancer, in the EU and in all six countries considered, again confirming the long-term favourable trends for these sites [4, 5, 12]. Improvements in therapies, early diagnosis and screening have most likely contributed to these trends, albeit differently for each type of cancer.

The pancreas is the only major cancer site for which no improvement in rates is predicted for either sex and, if anything, a slight increase in rates is expected. Long-term trends have shown increases in both sexes in the EU up to the late 1980s, followed by a levelling off in rates up to the end of the millennium, and possibly a slight increase in most recent years [18]. Albeit diagnostic improvements may, at least in part, account for the early rises, trends in more recent years are difficult to interpret. Cigarette smoking, the best recognized risk factor, cannot account for recent trends in men, given that lung cancer has been declining. Increases in obesity prevalence may play a role in recent trends [18]. The pancreas is presently the fourth cancer mortality site in the EU for both sexes, having recently overtaken stomach cancer rates in both sexes and uterine cancer rates in women.

The steady increase in lung cancer mortality in women in the EU is expected to continue. Breast cancer rates are expected to still be higher than lung cancer rates in women in the EU in 2013, although the difference is small (14.6 versus 13.9/100 000 women). However, if the opposite trends in breast and lung cancer mortality rates continue in the near future, in 2015 lung cancer may become the first cause of cancer mortality in women as well. This is already true in the UK and in Poland, the two countries with the highest rates. A joinpoint regression analysis [13] showed that while in Poland rates have steadily increased, in the UK rates increased up to the late 1980s, subsequently declined up to the early 2000s, and increased again in more recent years. An age-period-cohort analysis [13] showed that in most countries, and in the EU as a whole, cohort effects increased in women born between 1940 and 1970, followed by declines for more recent cohorts, albeit based on small numbers. Conversely, in the UK, the highest cohort effects were in women born in the 1920s, followed by declines in risk, and then a plateau for women born in the 1940s, followed by ulterior declines in more recent generations. It is, therefore, possible that the recent increase in lung cancer mortality in UK women is transient, due to the additional rises in smoking prevalence observed in the 1970s; the favourable trends in younger women in the UK as well as in several other European countries suggest that a levelling off with rates around 15/100 000, and possibly some decrease in

Table 2. Standardized colorectal cancer mortality death rates for all-ages, 35–64 and 65–79 years in the quinquennia 2000–2004 and 2005–2009 with percentage difference and 2013 predicted all-ages rate in the EU and selected countries.

	All ages standardized death rate 2000–2004	All ages standardized death rate 2005–2009	% Difference 2000–2004 versus 2005– 2009	Predicted all- ages standardized rate for 2013	35–64 years standardized death rate 2000– 2004	35–64 years standardized death rate 2005– 2009	% Difference 2000–2004 versus 2005– 2009	Predicted 35–64 years standardized rate for 2013	65–79 years standardized death rate 2000– 2004	65–79 years standardized death rate 2005– 2009	% Difference 2000–2004 versus 2005– 2009	Predicted 65–79 years standardized rate for 2013
Men												
France	17.33	15.67	–9.62	13.95	17.49	16.25	–7.09	15.49	161.10	141.10	–12.41	113.95
Germany	18.92	16.23	–14.25	13.63	19.96	17.00	–14.82	13.60	177.95	152.16	–14.49	129.43
Italy	18.06	16.38	–9.31	15.29	19.04	16.80	–11.80	15.17	165.27	150.59	–8.89	142.18
Poland	20.17	20.70	2.62	21.75	22.55	22.02	–2.37	24.24	198.85	207.42	4.31	214.48
Spain	18.64	18.30	–1.80	18.64	19.59	19.38	–1.09	19.47	172.30	167.31	–2.90	174.67
UK	17.85	16.76	–6.09	16.31	18.98	17.30	–8.85	17.95	170.15	156.38	–8.09	142.56
European Union (27)	18.78	17.60	–6.25	16.71	20.16	18.74	–7.05	18.18	175.72	163.69	–6.84	152.28
Women												
France	10.09	9.08	–10.02	8.13	10.95	10.08	–7.99	9.47	81.51	71.43	–12.37	58.46
Germany	11.98	10.03	–16.26	8.50	12.15	10.48	–13.79	8.70	101.26	82.86	–18.17	70.53
Italy	11.13	10.08	–9.36	9.25	13.15	11.85	–9.85	10.64	87.97	80.73	–8.23	73.16
Poland	12.01	11.34	–5.57	10.84	14.09	13.45	–4.53	13.50	107.51	100.42	–6.59	93.14
Spain	10.24	9.44	–7.82	9.02	12.10	10.87	–10.12	10.96	81.34	75.97	–6.60	67.97
UK	11.09	10.69	–3.67	9.82	11.99	11.77	–1.78	11.10	97.80	90.71	–7.26	75.53
European Union (27)	11.42	10.45	–8.50	9.54	12.80	11.80	–7.81	11.39	95.56	86.75	–9.21	73.84

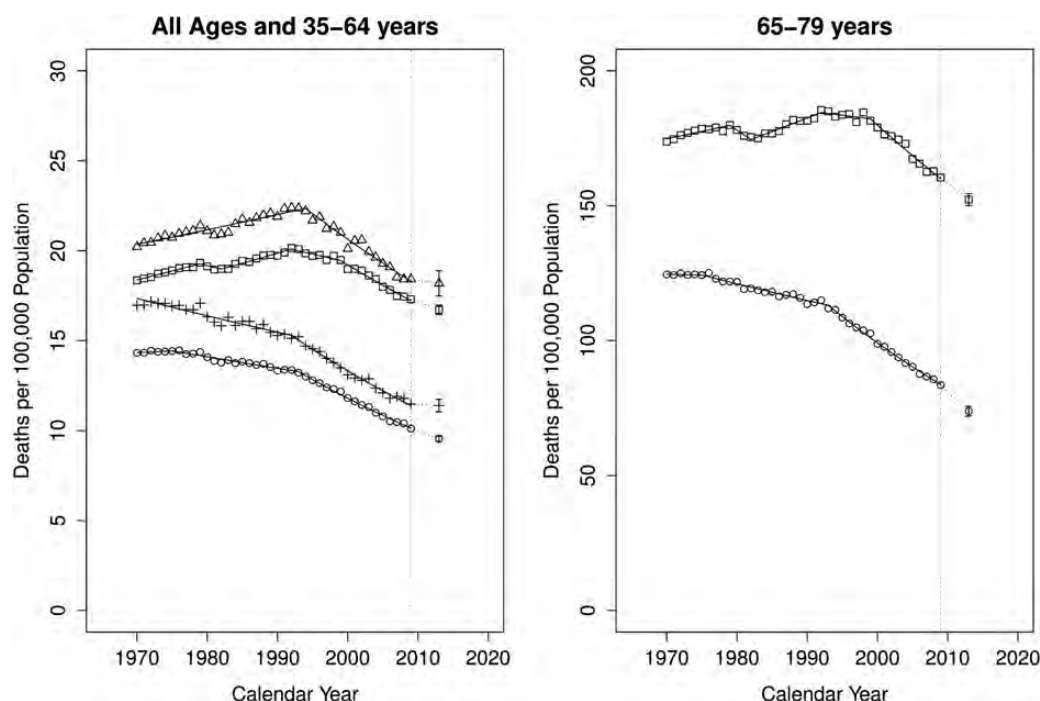


Figure 5. Annual age-standardized colorectal cancer death rates in the EU per 100 000 population for all-ages, 35–64 and 65–79 year age groups from 1970 to 2009 and the resulting joinpoint regression models. In addition to the predicted rates for the year 2013 with 95% prediction intervals. On the left, male all-ages (squares), male 35–64 years (triangles), female all-ages (circles) and female 35–64 years (crosses). On the right, male 65–79 years (squares) and female 65–79 years (circles).

lung cancer mortality rates in EU women, could occur after 2020 [19].

Mortality from intestinal cancer (chiefly colorectal cancer) is predicted to decline by 3.4% in men and 5.6% in women in the EU between 2009 and 2013, again maintaining favourable trends observed since the early 1990s in men and the early 1980s in women. However, while substantial declines are predicted for all the six major countries in women, ranging from –4% in the UK to –8.7% in Germany, patterns in men are more heterogeneous. Declines around 8% are predicted in France and Germany, around 4% in Italy, but only around 1% in Spain and the UK, while a slight increase in rates (+1.4%) is predicted for Poland. Although there were large differences in intestinal cancer mortality rates in the early 1970s, converging patterns have been observed across various areas of Europe [20]. As a consequence, intestinal mortality rates in 2013 show less variation across major European countries than other cancer sites, particularly in women, where the lowest rate in France is only 25% lower than the highest rate in Poland. A more homogeneous lifestyle (including diet) across Europe may explain the converging pattern in colorectal cancer rates. Improvements in therapies and screening/early diagnosis have had a favourable impact on mortality. It is, however, difficult to explain the different patterns between the two sexes in some, but not all, countries. The earlier more favourable trends in women may be attributed in part to more favourable dietary and lifestyle habits in women, and in part to the introduction of oral contraceptives and other exogenous female hormone preparations in the 1950s and 1960s [21]. Following the early stopping of the Women's Health Initiative in 2002 [22]

(a randomized trial comparing combined hormone replacement treatment (HRT) to placebo), because the overall health risks exceeded the benefits, falls in HRT use were reported in the US as well as in several European countries [23]. Falls in breast cancer incidence in some countries have been related to these decreases in HRT use [23]. Given the postulated protective effect of HRT on colorectal cancer, the reduced HRT use should lead to a less favourable pattern in colorectal cancer incidence in women. However, it may still be too early to detect effects on mortality rates.

While until recently (up to 2009) younger age groups appeared to have even more favourable trends [24], suggesting further improvements in the overall rates in the future, the predictions for the year 2013 do not support this observation anymore. Given the uncertainties inherent in prediction models, this should be considered with utmost care. If true, however, this may suggest less favourable trends in the future. On the other hand, organized colorectal cancer screening has been introduced in several European countries relatively recently, and it is generally not offered to younger age groups [25]. Therefore, when the potential benefits of screening start to affect mortality, an effect is to be expected above a certain age only.

In conclusion, cancer mortality prediction for the year 2013 confirms the favourable trend in overall cancer mortality in the EU, as well as in several major cancer sites, with the notable exceptions of pancreatic cancer in both sexes, and lung cancer in women, which seems set to become, within a few years, the first cause of cancer mortality in women as well, overtaking breast cancer.

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disclosure

The authors have declared no conflicts of interest.

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